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L27: Entry 3 of 3

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TITLE: Enhanced global navigation satellite systemAbstract Text (1):

An enhanced positioning and navigational system for use within a building or otherwise separated by a line-of-sight barrier from an orbiting global navigation satellite system such as Navstar GPS. An antenna placed at a known location within line of sight of orbiting global navigation satellites receives global position and navigation signals and relays the signals through the line-of-light barrier to an identifier which identifies the signals and couples the signals for individual broadcast from each of an array of broadcast antennae located at known fixed locations within the building (behind the line-of-sight barrier). A receiver located within the building receives the signals broadcast from the antenna array and through use of a processor interprets the signals to provide position and navigation information to the user of the receiver.

Abstract Text (2):

In an alternate embodiment, a signal generator generates navigation and positions information signals of a multiplicity of broadcast beacons. The information signals are separated into parcels corresponding to individual beacons and then are separately broadcast from each of all array of antennae located at fixed, known locations within a building. A radio position and navigation receiver equipped with a processor provided with appropriate software receives the signals and provides radio position and navigation receiver information to the user of the GPS receiver. In another alternative embodiment, plural pseudolites are placed at accurately established fixed locations within a building. A controller causes the pseudolites to sequentially broadcast global navigational satellite system signals. A GPS receiver equipped with a processor provided with appropriate software receives the signals and provides navigation and positioning information to the user of the GPS receiver. Alternative methods for sequencing the signals broadcast by the pseudolites are also disclosed.

Application Filing Date (1):

19980919

Parent Case Text (2):

This application claims the benefit under 35 U.S.C. .sctn.119(e) and 37 C.F.R. .sctn.1.78 of copending provisional patent application entitled "Enhanced Global Position System", Ser. No. 60/060,515 filed Sep. 30, 1997, from which this application claims priority. The disclosure of provisional patent application Ser. No. 60/060,515 is hereby incorporated in its entirety.

Brief Summary Text (2):

The present invention relates generally to facilitating the use of radio signals for positioning and navigation where a barrier (solid or non-solid) precludes direct usage of public line-of-sight radio positioning/navigation beacons. Although several embodiments of the present invention are described herein, the focus is on the use of repeated geometrically non-linear Global Navigation Satellite System

signals within a line-of-sight barrier.

Brief Summary Text (4):

A common need of our society is to accurately track and record positions of aircraft, land vehicles, geographical landmarks, materials, buildings, animals, people, and other items. One system currently used to accomplish this goal in direct line-of-sight is use of public radio positioning/navigation signals and associated equipment. Radio positioning/navigation can be broadly defined as the use of radio waves to transmit information, which in turn can then be received and utilized to determine position and to navigate. Some radio positioning/navigation systems currently in use are Loran, Omega, LMN, DGPS, and Global Navigation Satellite Systems (GNSS) such as NAVSTAR, GLONASS (the Russian variant), and European systems (GNSS1, GNSS2, NAVSTAT and GRANAS). The radio navigation systems quickly becoming the standard worldwide are Global Navigation Satellite Systems (GNSS) including, in the United States, the NAVSTAR Global Positioning System.

Brief Summary Text (5):

The NAVSTAR GPS signal transmission system presently consists of twenty-four orbiting satellites, spaced in six separate circular orbits, with each accommodating four satellites. Of these, twenty-one are normally operational and three serve as spares. Each NAVSTAR GPS satellite reappears above the same ground reference approximately every twenty-three hours and fifty-six minutes. The spacing of satellites is designed to maximize probability that earth users will always have at least four satellites in good geometrical view for navigational use.

Brief Summary Text (6):

The basic method of position determination via radio positioning and navigation signals derives from the concept of triangulation. The term triangulation used herein refers to the general process of determining distance, a.k.a. range, from the present position to multiple known beacons, and mathematically solving for the point in space which satisfies these conditions. As applied to GNSS, the procedure requires calculation of signal travel time, which, when multiplied by the speed of light, renders distance.

Brief Summary Text (7):

In support of this computation, the normal radio signals transmitted by each broadcasting NAVSTAR GPS satellite are currently configured as follows: a 1575.42 MHZ "L1" carrier modulated by the 10.23 MHZ P-code (Precision), the 1.023 MHZ C/A-code (Coarse/Acquisition), and the 50 Hz navigation code; and a 1227.60 MHZ "L2" carrier modulated by the 10.23 MHZ P-code and the 50 Hz navigation code. Because the system was principally designed for military use, the P-code is classified, and the L2 carrier is not officially supported for civilian use.

Brief Summary Text (9):

The NAVSTAR GPS navigation message transmits various data including precise time information every six seconds, orbital parameters (ephemeris data), correction statistics, and satellite status. The basic data is divided among five frames over thirty seconds, with the total message spread over 12.5 minutes. The layout of data is designed such that once a receiver has accumulated the necessary background data, it acquires an update of precise time every six seconds from which navigation calculations can be made. The position of the satellite at time of transmission is computed based on its known orbital path along with current ephemeris data.

Brief Summary Text (10):

Initial range calculations are called "pseudoranges" since receiver clocks are not precisely synchronized to NAVSTAR GPS time, and propagation through the atmosphere introduces delays into the navigation signal propagation times. These result, respectively, in clock bias error and atmospheric bias error. Clock bias errors may be as large as several milliseconds.

Brief Summary Text (11):

Conventionally, a minimum of four GNSS satellites are sampled to determine a terrestrial position estimate (e.g. Cartesian X,Y,Z coordinates; or longitude, latitude, and altitude in any of various systems including WGS84, NAD83, NAD27, Indian, etc.). Three of the satellites are used for basic triangulation, and a fourth is used to solve for clock bias between the satellite system and the receiver. Ephemeris correction statistics from the navigation message assist in amelioration of atmospheric bias.

Brief Summary Text (12):

Other errors which affect GNSS position computations include receiver noise, signal reflections, shading, satellite path shifting, and in the case of NAVSTAR GPS, purposely induced accuracy degradation called selective availability (S/A).

Brief Summary Text (13):

A process known as differential positioning compensates for many of the errors which are common in radio positioning/navigation systems. An antenna at a known location receives line-of-sight (LOS) GNSS signals and broadcasts a signal with current correction adjustments for each satellite which can be received by any differential receiver within its signal range.

Brief Summary Text (14):

Location accuracy via GNSS is continually evolving. Standard GNSS receivers can typically produce position estimates within $\pm .60$ -100 meter accuracy. Sub-meter accuracy of location can be achieved using differential positioning, known as DGPS. Some other techniques for improving accuracy are "Carrier-phase GPS", "Augmented GPS", and GPS Interferometry.

Brief Summary Text (15):

GNSS relies on no visual, magnetic, or other point of reference and this is particularly important in applications such as aviation and naval navigation that traverse polar regions where conventional magnetic navigational means are rendered less effective by local magnetic conditions. Magnetic deviations and anomalies common in standard radio positioning/navigation systems do not hinder GNSS. In addition, GNSS equipment is typically fabricated of standard, solid state electronic hardware, resulting in low cost, low maintenance systems, having few or no moving parts, and requiring no optics. GNSS does not have the calibration, alignment, and maintenance requirements of conventional inertial measuring units. Also, GNSS is available 24 hours per day on a worldwide basis.

Brief Summary Text (16):

During the development of the NAVSTAR GPS program the United States Government made decisions to extend its use to both domestic and international communities. Its applications range from navigation over the land, in the air, and on the seas, to precision surveys, the tracking of trains and trucks, and even locating undetonated mines left behind in the Gulf War. It is important to note that GNSS solutions are only accomplished when the GNSS receiver is in direct line-of-sight (LOS) with the orbiting GNSS satellites. In other words, if the GNSS receiver's antenna is used in heavily forested areas, in steep and narrow canyons, within a structure, or adjacent to the outer walls of buildings, the GNSS receiver will be unable to obtain a good repeatable reading, or in many cases, any reading at all.

Brief Summary Text (17):

What is needed is a system that relays GNSS signals beyond a line-of-sight barrier (LSB) and mathematically corrects satellite pseudorange calculations to account for geometrically nonlinear satellite signal paths. The result of such a system is accurate, consistent readings for multitudes of applications which need, or require, positioning and navigation information when out of the line of sight of a GNSS satellite system.

Brief Summary Text (19):

The present invention provides a system for use of GPS receivers separated by a barrier from being in the line of sight of orbiting GNSS satellites, hereinafter referred to as "within a line-of-sight barrier". An exterior receiving antenna is positioned outside the line-of-sight barrier at a known location to receive ephemeris and pseudorange signals from a GNSS system of orbiting satellites. Optional correction signals from a DGPS antenna may also be used. The signals received by the exterior antenna are passed through the line-of-sight barrier, such as a building roof, to a signal identifier which identifies and may amplify the signals and then transmits the signals to a plurality of broadcast antennae placed at known locations within the line-of-sight barrier, preferably at differing spacings from the ceilings of the building in which the invention is being employed. Each of the broadcast antennae broadcasts the identified signals either sequentially or at different frequencies. A standard GPS receiver capable of receiving GPS and optional DGPS signals may be co-positioned with the exterior antenna. The retransmitted signals are received by a GPS receiver coupled to a host computer. Allowance for the displacement of the signal path from a linear path to a three-dimensional multilegged path is made by the host computer in order that the data received by the GPS receiver operating within the line-of-sight barrier is used to calculate the position into that which would be received by the receiver if no roof or other line-of-sight barrier interrupted the line-of-sight path of the GPS signals transmitted by the orbiting GNSS satellites.

Brief Summary Text (20):

In an alternate embodiment of the invention, a plurality of broadcast antennae located within a building emit signals imitative of a GNSS system of satellites. Line-of-sight data received by GPS receivers located in the building from any four of the broadcast antennae permit the GPS receivers to display or transmit location, altitude and navigational data while in line-of-sight range of any four interior broadcast antennae.

Brief Summary Text (22):

The present invention specifically comprises a receiver with antenna positioned in direct line-of-sight of a public radio positioning/navigation transmission system (e.g. GNSS, NAVSTAR GPS, GLONASS). The acquired signals are passed through the line-of-sight barrier, identified, amplified (as needed), and relayed to a strategically arrayed constellation of broadcast antennae. The radio positioning/navigation receiver located within a line-of-sight barrier receives the repeated, geometrically non-linear signals and utilizes appropriate software to calculate its coordinates within a line-of-sight barrier, to be used for positioning and navigational purposes.

Brief Summary Text (23):

The present invention utilizes the following: GPS receiving antenna, signal identifier/amplifier/repeater (IAR), GPS broadcast only antennas, GPS receivers, supplemental data links and a host computer/data processor, GPS signal processing software, and three-dimensional, parametric, database-driven, geometric solution software (vector geometry). Optionally, a DGPS receiving antenna and DGPS receivers may be used for enhanced accuracy.

Brief Summary Text (24):

The primary method of accomplishing the objective utilizes geometrically non-linear, non line-of-sight, repeated GPS signals to calculate accurate location data for applications within a line-of-sight barrier (LSB).

Brief Summary Text (25):

The primary invention is an accurate extension of GPS from a line-of-sight only (LOS) to a system that can be used within a line-of-sight barrier (LSB) which derives data from the GPS satellite signals and the optional DGPS correction signals, which are passed through a line-of-sight barrier (LSB), and used in

conjunction with a supplemental data link and a host computer/data processor.

Brief Summary Text (26):

The system derives accurate position information from line-of-sight data signals directly from the GPS satellites, and optional DGPS antennae at a fixed receiver location outside the line-of-sight barrier (LSB). The GPS receiver operating in line-of-sight view of the GPS satellites then transmits positional data to a host computer database. Simultaneously, the signals are passed through the line-of-sight barrier (LSB) to a signal identifier/amplifier/repeater (IAR). After the signals are identified, they are sent to a set of broadcast antennas located at known fixed locations, contained within the line-of-sight barrier (LSB). The receiver within the line of sight barrier (LSB) then directly receives the repeated, passed through GPS signals that can be processed and used within the line-of-sight barrier (LSB) for location and navigation purposes that are ultimately only an extension of an existing GPS.

Brief Summary Text (27):

Alternatively, a secondary general configuration is a more self-contained system that will create line-of-sight positioning data within a line-of-sight such as a building. This secondary solution to the present invention will employ its own master clock, a host computer/data processor, GPS broadcast-only antennas, signal amplifiers, supplemental data links, GPS signal processing software, and specially programmed three-dimensional, parametric, database-driven, geometric solution software, and GPS receivers.

Brief Summary Text (28):

It is an object of the invention to utilize GNSS satellite radio positioning/navigation signals which have been acquired outside a line-of-sight barrier.

Brief Summary Text (32):

It is still a further object of the invention to integrate commercially available processor hardware and software to collect standard GNSS signals and associated data to calculate positioning and navigation solutions within a line-of-sight barrier.

Brief Summary Text (33):

It is still a further object of the invention to utilize GPS information for recording the locations of people, resources, products, inventory, work-in-process all outside the line of sight of the global navigation satellite system satellites.

Brief Summary Text (36):

Global Navigation Satellite System (GNSS)--A generic term for specific systems such as the Russian GLONASS and the United States NAVSTAR GPS, utilizing equipment which receives signals from a relevant constellation of navigational satellites in earth orbit.

Brief Summary Text (37):

NAVSTAR Global Positioning System (NAVSTAR GPS)--The United States Government's satellite navigation system which broadcasts time and ranging data globally. Designed to provide a highly accurate, reliable, continuous 24-hour, worldwide coverage for position reporting and navigation.

Brief Summary Text (38):

Differential Global Positioning System (DGPS) or Differential Global Navigation Satellite System (DGNSS)--A positioning system which also includes an antenna that is precisely surveyed to a known location. The antenna receives GPS signals and broadcasts current correction data for each satellite which can be received by a DGPS antenna. Location accuracy within one meter can be achieved.

Brief Summary Text (41):

Line-of-Sight--(LOS) Unobstructed linear signal path between radio positioning/navigation transmitters and receiving antennae.

Brief Summary Text (42):

Line-of-Sight Barrier--(LSB) Any barrier, solid or non-solid, that restricts direct linear receipt of any radio positioning/navigation signal.

Brief Summary Text (44):

Selective Availability (S/A)--The Military dithers the satellite clock and manipulates ephemeris data to deny navigational precision to potential adversaries. These errors, in turn, lead to a reduction in precision of position estimates.

Brief Summary Text (45):

Simulated Global Navigation Satellite System (SGNSS)--GNSS satellite data which is generated and broadcast within a line-of-sight barrier.

Brief Summary Text (46):

Radio Positioning/Navigation Signal (RPNS)--Any radio positioning/navigation signal, such as LORAN, OMEGA, etc. broadcast within a line-of-sight barrier.

Brief Summary Text (47):

Receiver--Hardware that is capable of receiving radio positioning/navigation signals

Brief Summary Text (49):

a. Integrated Processing System (IPS)--A radio positioning/navigation receiver with an integrated solution processor.

Brief Summary Text (50):

b. External Processing System (EPS)--A radio positioning/navigation receiver that is linked via RF or hardwire to an external computer data processor.

Brief Summary Text (52):

Wide Area Augmentation System (WAAS)--A system where a network of ground reference stations monitors GNSS satellite signals and passes the information to a Master Station. The Master Station uplinks correction data to Geostationary satellites (not the GNSS navigation satellites) which in turn downlink the correction data to a user's GNSS receiver. This system is designed to improve integrity, accuracy, availability, and continuity of service, with a view to accuracy being compatible with aircraft approach and landing aids, and other uses where such accuracy is required.

Brief Summary Text (53):

Triangulation--Any mathematical procedure to calculate position based on the intersection of ranges from known points (includes all variations such as trilateration and resection, etc., whether or not angles, per se, are used).

Detailed Description Text (3):

The present invention is a system which can fulfill the position/navigation accuracy of locating a radio positioning/navigation receiver operating within a line-of-sight barrier 100 using passed through, geometrically non-linear radio positioning/navigation signals. In the preferred embodiment of the present invention, this is accomplished by utilizing standard, and/or modified, radio positioning/navigation hardware and integrating commercially available software into a signal and data processor without the need for additional data or communication.

Detailed Description Text (5):

FIG. 1 illustrates the general configuration of the preferred embodiment of the present invention of a radio positioning/navigation system which is operating within a solid or non-solid line-of-sight barrier 100. Examples of a solid line-of-sight barrier 100 include the roof of a structure, a heavy tree canopy, steep and narrow canyon walls, the walls of tall buildings, or within any enclosure. Examples of non-solid line-of-sight barriers 100 would include, but are not limited to, atmospheric anomalies, magnetic fields, etc.

Detailed Description Text (6):

The basic necessary elements of this system used to determine the positioning and navigational coordinates of a radio positioning/navigation receiver operating within a line-of-sight barrier 100 include: a constellation of broadcast antennae 130, 131, 132, 133 accurately surveyed to fixed, known locations relative to the user's choice of system coordinates, and a mobile receiver/processor 150 operating within the line-of-sight barrier 100 within line of sight of the broadcast antennae 130, 131, 132, 133. The broadcast antennae 130, 131, 132, 133 are arranged in a geometrical pattern that is efficient for accurate triangulation with either a two- or three-dimensional radio positioning/navigation system, as applicable. Specifically, it should be noted that in a two-dimensional system the operating centers of the antennae are not all located co-linear, and in a three-dimensional system the operating centers of the antennae are not all located co-linear or co-planar. The transmission paths 140, 141, 142, 143 are direct line-of-sight distances from the fixed, known location, broadcast antennae 130, 131, 132, 133 to any mobile receiver/processor 150 which is operating within the line-of-sight barrier 100. A fixed receiver/processor 160 with appropriate software uses data received from GNSS antenna 200, to collect external pseudorange data, and transmits via transmission path 113 to processor 420. The mobile receiver/processor 150 with appropriate software, uses the radio positioning/navigation signals received from the broadcast antennae 130, 131, 132, 133 to collect total time of arrival of the signal from the satellites 101, 102, 103, 104. This data is transmitted via transmission path 113 to processor 420. Specifically, in a three-dimensional system the operating center of the antennae cannot all be located co-planar. The transmission paths 140, 141, 142, 143 are direct line-of-sight distances from the broadcast antennae 130, 131, 132, 133 to the mobile receiver/processor 150 which is operating within line-of-sight barrier 100. The processor 420 with appropriate software, uses the data collected from mobile receiver/processor 150 and fixed receiver/processor 160 to determine the present coordinates of mobile receiver/processor 150 by appropriate two- or three-dimensional geometric triangulation.

Detailed Description Text (7):

The preferred embodiment of the present invention illustrated in FIG. 1 focuses on the use of repeated, geometrically non-linear extension of GNSS signals within a line-of-sight barrier 100. Twelve or more GNSS satellites may be in line of sight of the GNSS antenna 200. At any one time only four satellites are needed for three-dimensional position determination, and are thus shown for clarity (more or fewer may be used in applications as desirable). These satellites are labeled as 101, 102, 103, 104. The fixed receiver/processor 160 may be located inside or outside the line-of-sight barrier 100. The GNSS signals are passed through the line-of-sight barrier 100, split by signal splitter 109, and transmitted via transmission paths 110 and 111 to the Identifier/Amplifier/Repeater 115 and receiver/processor 160 respectively. These transmission paths 110 and 111 may be either hard wired, or wireless. Transmission path 110 will cause individual time delays of the satellite signals which are being repeated. These delays in time must be factored into the calculation of the positioning and navigational coordinates for the mobile receiver/processor 150 operating within a line-of-sight barrier 100.

Detailed Description Text (8):

The Identifier/Amplifier/Repeater 115 identifies the individual GNSS satellites 101, 102, 103, 104 by any of the following methods either singularly or in

combination: splitting, tuning, heterodyning and deheterodyning (frequency shifting), tagging within the GNSS navigation signal. In one variation, the Identifier/Amplifier/Repeater 115 may separate the GNSS signals into identified separate signals corresponding to the individual signal sets received from each of satellites 101, 102, 103, 104. The Identifier/Amplifier/Repeater 115 amplifies, and selects a channel to transmit the passed through satellite data via transmission paths 120, 121, 122, 123 to broadcast antennae 130, 131, 132, 133 respectively.

Detailed Description Text (10):

These broadcast antennae 130, 131, 132, 133 are selectively located at fixed, known locations relative to the user's choice of system coordinates. The transmission paths 120, 121, 122, 123 cause individual time delays of the satellite signals which are being passed through the Identifier/Amplifier/Repeater 115 and repeated within the line-of-sight barrier 100. Passage of signals through the Identifier/Amplifier/Repeater 115 causes an individual time delay that must also be factored into the calculation to determine the positioning and navigational coordinates of the mobile receiver/processor 150 operating within the line-of-sight barrier 100. The transmission paths 140, 141, 142, 143 are direct line-of-sight distances from the broadcast antennae 130, 131, 132, 133 to the mobile receiver/processor 150 which is operating within the line-of-sight barrier 100.

Detailed Description Text (11):

In order to calculate the position of a mobile receiver/processor 150 operating within a line-of-sight barrier 100, normal vector geometry techniques are utilized. The position/navigation solution of the mobile receiver/processor 150 is relative to the location of the broadcast antennae 130, 131, 132, 133 located within a line-of-sight barrier 100. The solution calculates the standard Cartesian X,Y,Z coordinates, or latitude/longitude/altitude, or customized local coordinate systems. For those versions of the invention which involve relaying public navigation/position signals and retransmitting them within a line-of-sight barrier 100 (as opposed to signal generation within the line-of-sight barrier 100), a unique innovation is incorporated into the triangulation algorithm in order to account for the geometrically non-linear signal path. The core of the solution resides in use of the real space, three-dimensional, parametric, database driven, graphical solution software.

Detailed Description Text (19):

Works by representing the specific positioning and navigational results graphically.

Detailed Description Text (20):

FIG. 4 illustrates the processor 420 which receives the geometrically non-linear, repeated GNSS data via transmission path 410 within a line-of-sight barrier. Processor 420 receives external pseudorange data via transmission path 113. Processor 420 uses data acquisition software (DAQ) 510, relational database management software 515, satellite position prediction software 520, and three-dimensional, parametric, database-driven, graphical software 530 which will calculate a post-processed solution of the repeated, geometrically non-linear GNSS or radio positioning/navigation signals which have been passed through line-of-sight barrier. Processor 420 may be a personal computer capable of operating the "Windows 95" operating system of Microsoft Corp. and may be of the type equipped with a Pentium processor operating at no less than 100 MHz and having internal memory of at least 16 megabytes. Processor 420 may be internal or external. An external processor may be shared with multiple mobile receiver/processors 150.

Detailed Description Text (23):

Magellan GPS Post Processing Software published by Magellan System;

Detailed Description Text (30):

GNSS Satellite Position Prediction Software 520 (Optional):

Detailed Description Text (32):
Jupiter 4.0 published by Position Inc.;

Detailed Description Text (43):
FIG. 4 also represents the processor 420 which is receiving a plurality of GNSS satellite or other public RF navigation/positioning geometrically non-linear signals which are transmitted via transmission path 410. The processor 420 collects the radio positioning/navigation data elements which include satellite pseudorange, satellite vehicle identification, time tags, GNSS week, GNSS time, GNSS almanac data, longitude, latitude, and altitude, which are contained or derived from satellite signals which are transmitted via transmission path 410. The processor 420 uses information generated by the GNSS satellite prediction software 520, and any optional differential data. The data acquired from the DAQ software 510 and the GNSS satellite prediction software 520 is exported directly to the relational database management software 515. The data is then categorized into appropriate fields of information in various data tables by the relational database management software 515.

Detailed Description Text (44):
The appropriate template or model created for the defined space within a line-of-sight barrier is used by the three-dimensional, parametric, database-driven, graphical software 530 which is driven by data exported by the relational database management software 515. The three-dimensional, parametric, database-driven, graphical software 530 solves the position/navigation location of mobile receiver/processor 150 operating within line-of-sight barrier 100.

Detailed Description Text (45):
The positioning/navigation location solution data are digitally output via data link 540 in various formats and utilized by other radio positioning/navigation receiver(s) operating within or outside of a line-of-sight barrier, by GIS software, or a host computer database.

Detailed Description Text (46):
FIG. 4 illustrates the post processed solution to the position/navigation coordinates (X11, Y11, Z11) of mobile receiver/processor 150 within the line-of-sight barrier 100.

Detailed Description Text (47):
To further understand the calculations and data needed to solve the position/navigation locations of a mobile receiver/processor 150 within a line-of-sight barrier 100 using repeated, geometrically non-linear signals, the following data elements must be determined:

Detailed Description Text (65):
All of the above data elements are known except for external pseudoranges 105, 106, 107, 108, and the lengths of transmission paths. Upon the acquisition or prediction of the external pseudoranges 105, 106, 107, 108 by the fixed receiver/processor 160 or satellite position prediction software 520, the problem will be reduced to one set of unknowns, namely lengths of transmission paths 140, 141, 142, 143 respectively for each of the above equations. Simple subtraction will yield the solution of the unknowns for the length of these transmission paths 140, 141, 142, 143.

Detailed Description Text (76):
All of the above data elements are known except for external pseudoranges 105, 106, 107, 108, and the lengths of transmission paths. Upon the acquisition or prediction of the external pseudoranges 105, 106, 107, 108 by the fixed receiver/processor 160 or satellite position prediction software 520, the problem will be reduced to one set of unknowns, namely lengths of transmission paths 140, 141, 142, 143

respectively for each of the above equations. Simple subtraction will yield the solution of the unknowns for the length of these transmission paths 140, 141, 142, 143.

Detailed Description Text (83):

a. The position of the mobile receiver/processor(s) 150 is represented by earth-centered coordinates (X11,Y11,Z11). These coordinates are determined by intersecting spheres which have radii equal to the internal pseudoranges 140, 141, 142, 143 which emanate respectively from fixed known location broadcast antennae 130, 131, 132, 133.

Detailed Description Text (84):

b. Once that the position (X11,Y11,Z11) of receiver(s) 150 has been solved, the parametric graphical solution software 530 can calculate by using normal three-dimensional vector geometry the calculated pseudoranges 605, 606, 607, 608 from the satellites 101, 102, 103, 104 by knowing the earth-centered Cartesian X,Y,Z coordinates of each satellite 101, 102, 103, 104 and the earth-centered Cartesian coordinates of any mobile receiver/processor 150 operating within the line-of-sight barrier 100.

Detailed Description Text (85):

The earth-centered Cartesian coordinates (X11,Y11,Z11) which represent position, or discreet locations which can be averaged over time for navigation purposes or representations, may be transferred via data link 540 in multiple ways to various types of equipment in order to make the positioning/navigation data useful. The following are examples and are not all inclusive:

Detailed Description Text (86):

GIS maps for two- and/or three-dimensional positioning and navigational purposes.

Detailed Description Text (87):

Host computer with database for positioning and navigational analysis.

Detailed Description Text (90):

FIG. 2 illustrates an alternative embodiment of the present invention which focus on the use of repeated, geometrically non-linear extensions of simulated GNSS (GNSS) signals, or any radio positioning/navigation signals (RPNS) within a line-of-sight barrier 100. In the first alternative embodiment of the present invention illustrated in FIG. 2, the SGNSS or RPNS signals are software generated and synchronized using a high grade clock. The satellite signal generator 201 is comprised of a computer/processor 202 with appropriate software that creates SGNSS or RPNS signals. The signal generator is outfitted with software that provides the logic to drive a switching mechanism 205. After the SGNSS or RPNS signals pass through the switching mechanism 205 they are amplified by a signal amplifier 206. This software will compute SGNSS or RPNS signal data as if it were received at the fixed location in space of the signal generator 201. This point simulates a SGNSS or RPNS receiving antenna and is necessary to provide a point of reference for collecting the SGNSS or RPNS data and simulating passing it through a line-of-sight barrier 100.

Detailed Description Text (92):

FIG. 3 illustrates the second alternative embodiment of the present invention. This second alternate embodiment also focuses on the use of GNSS signals or radio positioning navigation signals within a line-of-sight barrier 100. The combination of a transmitting antenna and signal generator is commonly referred to in the art as a pseudolite. Associated with each pseudolite 230, 231, 232, 233 within the line-of-sight barrier 100 is a satellite signal generator, which comprises a hardware subassembly similar to the signal generation section of a GNSS satellite (commercially available from companies such as Stanford Telecom). The pseudolites are synchronized with a computer/processor 203 outfitted with a high grade clock

and power switching mechanism 205.

Detailed Description Text (93):

Computer/processor 203 outfitted with a high grade clock and power switching mechanism 205 distributes power or a signal to initiate power via transmission paths 120, 121, 122, 123 to pseudolites 230, 231, 232, 233 respectively. These pseudolites 230, 231, 232, 233 are accurately surveyed to fixed known locations relative to the user's choice of system coordinates. The transmission paths 120, 121, 122, 123 will cause individual time delays of the sequenced power distribution. The transmission paths 140, 141, 142, 143 are direct LOS distances from the fixed, known location, pseudolites 230, 231, 232, 233 to the mobile receiver/processor 150 which is operating within a line-of-sight barrier 100. The mobile receiver/processor 150 with appropriate software, uses the GNSS positioning/navigation signals received from the pseudolites 230, 231, 232, 233, via the transmission paths 140, 141, 142, 143 located within the line-of-sight barrier 100 to determine its present coordinates by appropriate triangulation.

Detailed Description Text (94):

Differential accuracy enhancements are determined and may be applied to the various embodiments of the present invention. These differential corrections provide enhanced accuracy of the positioning/navigation data received within the line-of-sight barrier 100. The process known as differential positioning compensates for many of the errors which are common in radio positioning/navigation systems. An antenna at a known location receives line-of-sight GNSS signals and broadcasts a signal with current correction adjustments for each satellite which can be received by any differential receiver within its signal range. Location accuracy via GNSS is continually evolving. Standard GNSS receivers can typically produce position estimates within $\pm .60$ -100 meter accuracy. Sub-meter accuracy of location can be achieved using differential positioning, known as DGPS.

Detailed Description Text (95):

The DGNSS base station computes its position based on the current satellite data it is receiving. This computed position is compared to the known position of the DGNSS antenna. The time differences are calculated for each satellite currently in line-of-sight. These corrections are transmitted to any DGNSS receiver/processor for enhanced accuracy.

Detailed Description Text (96):

While certain embodiments of the system for providing GPS signals to receiver/processors operating within a line-of-sight barrier are described in detail above, it is contemplated that variations and modifications will be developed within the teaching of the present disclosure.

Current US Cross Reference Classification (2):

701/215

Other Reference Publication (1):

Ndili, Awele; "GPS Pseudolite Signal Design"; Sep. 1994.

CLAIMS:

1. Apparatus to determine the position of a GPS receiver separated by a line-of-sight barrier from a global navigational system having a plurality of satellites orbiting the earth, each of said satellites transmitting distinct navigational signals, comprising

a first antenna for receiving said navigational signals from said satellites,

a receiver/processor coupled to said first antenna,

said receiver/processor calculating location and navigation information from said navigational signals,

a signal identifier coupled to the first antenna,

said signal identifier identifying said navigational signals received by said first antenna and separating said navigational signals received by said first antenna into a multiplicity of separate data signals, each of said separate data signals identical to one of said distinct navigational signals transmitted by said plurality of satellites,

a plurality of broadcast antennae disposed within said line-of-sight barrier at fixed, predetermined locations,

each of said broadcast antennae coupled to said signal identifier to receive one of said separate data signals,

each of said separate data signals broadcast by one of said individual broadcast antennae distinct from said other of said data signals transmitted by said other of said individual broadcast antennae,

said signal identifier causing each of said broadcast antennae to broadcast said identified navigational signals in a manner distinguishable from the broadcast of said identified navigational signals by the other of said broadcast antennae,

a first computer coupled to said GPS receiver to receive said separate data signals received by said GPS receiver,

said first computer coupled to said receiver/processor to receive location and navigation information therefrom,

said first computer programmed to calculate a navigational result from each of said identified signals received by said GPS receiver and from said location and navigation information from said receiver/processor.

3. A method to determine the position of a GPS receiver separated by a line-of-sight barrier from a global navigational system which includes a plurality of satellites orbiting the earth which transmit navigational data, each of said plurality of satellites transmitting a distinct signal, comprising the steps of

receiving said navigational data from said plurality of satellites at a known location exterior to said line-of-sight barrier,

processing said navigational data to determine location and navigation information,

separating said received navigational data into a plurality of separate data signals, each of said separate data signals being identical to a one of said distinct signals transmitted by said plurality of satellites,

causing broadcast of said navigational data from a plurality of separate known locations, said broadcast of said navigational data distinguishable among each of said separate known locations,

said broadcast at each of said separate known locations being of a distinct one of said plurality of separate data signals,

computing a position of said GPS receiver from said navigational data broadcast from said plurality of separate known locations and from said location and navigation information.

5. The apparatus of claim 3 including the further step of

receiving a signal from a differential global positioning source at said known location exterior to said line-of-sight barrier,

causing broadcast of said signal from said differential global positioning source from said plurality of broadcast antennae.

6. A system for providing position and navigational information to a first unit which is separated by a line-of-sight barrier from a global navigational system, the global navigational system including a plurality of satellites orbiting the Earth which transmit navigational signals, the system comprising

first antenna means mounted within the line of sight of at least three of said plurality of satellites for receiving navigational signals from said at least three of said satellites,

a receiver/processor coupled to said first antenna means,

a plurality of broadcast antennae disposed within the line of sight of said first unit and coupled to said first antenna means,

each of said plurality of broadcast antennae disposed at a predetermined location,

means for broadcasting of said received navigational signals from each of said broadcast antennae such that broadcast of said navigational signals by one of said broadcast antennae is distinguished from broadcast of said navigational signals by the others of said broadcast antennae,

each of said broadcast antennae transmitting a distinct one of said navigational signals received by said first antenna means without modification thereof,

said first unit having a GPS receiver/processor associated therewith,

said GPS receiver/processor capable of receiving said navigational signals,

a host computer coupled to said GPS receiver/processor to receive said navigational signals received by said GPS receiver/processor,

said host computer coupled to said receiver/processor to receive location and navigation data therefrom,

said host computer programmed to calculate location and navigation information of said first unit from said navigational signals received by said GPS receiver.

9. A method to determine the position of a GPS receiver separated by a line-of-sight barrier from a global navigational system which includes a plurality of earth-orbiting satellites which transmit navigational data, comprising the steps of

receiving said navigational data from said plurality of satellites at a known location exterior to said line-of-sight barrier,

causing broadcast of said navigational data from a plurality of separate known locations,

said broadcast of said navigational data distinguishable among each of said separate known locations,

collecting the navigational data transmitted by said satellites, predicting or determining actual pseudoranges of said satellites, exporting the collected data and pseudoranges to a relational database, categorizing the data into appropriate fields of information,

computing a position of said GPS receiver from said navigational data broadcast from said plurality of separate known locations by use of vector geometry.

10. A system for providing position and navigational information to a first unit which is separated by a line-of-sight barrier from a global navigational system, the global navigational system including a plurality of satellites orbiting the Earth which transmit navigational signals, the system comprising

first antenna means mounted within the line of sight of at least three of said plurality of satellites for receiving navigational signals from said at least three of said satellites,

a plurality of broadcast antennae disposed within the line of sight of said first unit and coupled to said first antenna means,

each of said plurality of broadcast antennae disposed at a predetermined location,

means for broadcasting of said received navigational signals from each of said broadcast antennae such that broadcast of said navigational signals by one of said broadcast antennae is distinguished from broadcast of said navigational signals by the others of said broadcast antennae,

said first unit having a GPS receiver/processor associated therewith,

said GPS receiver/processor capable of receiving said navigational signals,

a host computer coupled to said GPS receiver/processor to receive said navigational signals received by said GPS receiver/processor,

said first antenna means is coupled to a stationary receiver/processor,

the stationary receiver/processor coupled to said host computer to communicate location information to said host computer,

said host computer programmed to calculate location and navigation information of said first unit from said navigational signals received by said GPS receiver.

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WEST Search History

DATE: Sunday, December 05, 2004

Hide?	Set Name	Query	Hit Count
<i>DB=EPAB,JPAB,DWPI,TDBD; THES=ASSIGNEE; PLUR=YES; OP=OR</i>			
<input type="checkbox"/>	L33	=20020826 and (different\$ adj2 data) and (updat\$ or refresh\$ or fresh\$)	9
<input type="checkbox"/>	L32	=20020826 and (different\$ adj2 data)	60
<input type="checkbox"/>	L31	=20020826 and ((differential adj data) with process\$)	1
<input type="checkbox"/>	L30	=20020826 and ((differential adj data) with process\$) and (updat\$ or fresh\$)	0
<input type="checkbox"/>	L29	=20020826 and ((differential adj data) with process\$) and (updat\$ or fresh\$)	0
<input type="checkbox"/>	L28	=20020826 and ((differential adj data) with process\$) and (updat\$ or fresh\$)	0
<i>DB=USPT; THES=ASSIGNEE; PLUR=YES; OP=OR</i>			
<input type="checkbox"/>	L27	L26 and (updat\$ or fresh\$)	3
<input type="checkbox"/>	L26	L25 and position\$	6
<input type="checkbox"/>	L25	L22 and ((differential adj data) with process\$)	6
<input type="checkbox"/>	L24	L22 and (differential adj data)	23
<input type="checkbox"/>	L23	L22 and (differen\$ adj2 data)	259
<input type="checkbox"/>	L22	L21 and l20	2008
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<input type="checkbox"/>	L20	=20020826	5903
<i>DB=EPAB,JPAB,DWPI,TDBD; THES=ASSIGNEE; PLUR=YES; OP=OR</i>			
<input type="checkbox"/>	L19	L18 and (velocity or speed\$)	8
<input type="checkbox"/>	L18	L17 and turn\$ and gain\$	24
<input type="checkbox"/>	L17	=20030417	10617
<input type="checkbox"/>	L16	=20030417	0
<i>DB=USPT; THES=ASSIGNEE; PLUR=YES; OP=OR</i>			
<input type="checkbox"/>	L15	L14 not l5	9
<input type="checkbox"/>	L14	L12 and (velocity or speed\$)	9
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<input type="checkbox"/>	L12	L10 and turn\$ and gain\$	11
<input type="checkbox"/>	L11	L10 turn\$ and gain\$	174088
<input type="checkbox"/>	L10	L3 and ("cross-track" or (cross adj1 track))	25
<input type="checkbox"/>	L9	L8 and l7	1

<input type="checkbox"/>	L8	L6 and gain\$	1
<input type="checkbox"/>	L7	L6 and gain\$ and turn\$	1
<input type="checkbox"/>	L6	L3 and (axle with position\$)	9
<input type="checkbox"/>	L5	L4 and (("off-set" or offset\$) with data)	3
<input type="checkbox"/>	L4	L3 and contour\$ and ("cross-track" or (cross adj l track))	6
<input type="checkbox"/>	L3	=20030417	628
<input type="checkbox"/>	L2	L1 and (dgps or (differential with position\$))	635
<input type="checkbox"/>	L1	701/23-25,36,41,201,202,205,213,214,215.ccls.	4233

END OF SEARCH HISTORY

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L31: Entry 1 of 1

File: DWPI

Jun 14, 1988

DERWENT-ACC-NO: 1988-183065

DERWENT-WEEK: 198826

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TITLE: Differential navigation system for remote mobile users - transmits, using spread spectrum techniques, computed differential data to commercial geosynchronous earth satellite relay

INVENTOR: LONGAKER, H L

PATENT-ASSIGNEE: OCEANONICS INC (OCEAN)

PRIORITY-DATA: 1986US-0821009 (January 21, 1986)

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[Search ALL](#)

[Clear](#)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
<input type="checkbox"/> <u>US 4751512 A</u>	June 14, 1988		010	

APPLICATION-DATA:

PUB-NO	APPL-DATE	APPL-NO	DESCRIPTOR
US 4751512A	January 21, 1986	1986US-0821009	

INT-CL (IPC): G01S 5/02; H04B 7/18

ABSTRACTED-PUB-NO: US 4751512A

BASIC-ABSTRACT:

The navigation system comprises a reference receiver of known location, situated no morethan 500 miles from the user, which reference receiver receives information from a navigation information service, computes differential data of the location of the reference receiver w.r.t. the information from the navigation service and communicates the computed differential data to a transmitting unit. A unit transmits, using spread spectrum techniques, the computed differential data to a commercial geosynchronous earth satellite relay.

A commercial geosynchronous earth satellite receives and relays the transmitted signal through a linearly polarised transponder. A non-directional circularly polarised non-stabilised antenna at the user receives the relayed signals. Navigation information is recieved at the user for the nagivation information service. A processor computes the location of the user using the navigation information and the computed differential data.

ADVANTAGE - High data error rate is eliminated.

ABSTRACTED-PUB-NO: US 4751512A
EQUIVALENT-ABSTRACTS:

CHOSEN-DRAWING: Dwg.2/4

DERWENT-CLASS: W02 W06
EPI-CODES: W02-K05; W06-A03;

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L33: Entry 1 of 9

File: JPAB

Jan 31, 2002

PUB-NO: JP02002032773A

DOCUMENT-IDENTIFIER: JP 2002032773 A

TITLE: DEVICE AND METHOD FOR PROCESSING MAP DATA

PUBN-DATE: January 31, 2002

INVENTOR-INFORMATION:

NAME

COUNTRY

KISHIKAWA, KIYONARI

HAYASHI, TOMOYOSHI

HATTORI, YAHEIJI

FUJISHITA, HIDEJI

ASSIGNEE-INFORMATION:

NAME

COUNTRY

ZENRIN CO LTD

HITACHI SOFTWARE ENG CO LTD

APPL-NO: JP2000216856

APPL-DATE: July 18, 2000

INT-CL (IPC): G06 T 11/60; G01 C 21/00; G08 G 1/0969; G09 B 29/00

ABSTRACT:

PROBLEM TO BE SOLVED: To automatically update user's map data by automatically preparing a map database by merging a plurality of maps and distributing the contents of the map database to a user through a communication line.

SOLUTION: A map merging device 91 first converts a plurality of types of map data of different data formats into standardized map data having a common data format, then calculates a finite difference between the map data and merges the map data by the finite difference data to prepare a map database 94. A map difference preparing device 95 compares the database 94 with map data 96 that are the same as map data held by the user and calculates the difference data 97 of both map data. User's car navigation device 99 and personal computer 101 download the difference data 97 through a public line network and update their own map data by using the difference data 97.

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L33: Entry 2 of 9

File: JPAB

Nov 30, 2001

PUB-NO: JP02001331493A

DOCUMENT-IDENTIFIER: JP 2001331493 A

TITLE: DEDUCTION DATA BASE ARCHITECTURE FOR MAP DATA

PUBN-DATE: November 30, 2001

INVENTOR-INFORMATION:

NAME

COUNTRY

ROBARE, PHILIP

ASSIGNEE-INFORMATION:

NAME

COUNTRY

NAVIGATION TECHNOL CORP

APPL-NO: JP2001083456

APPL-DATE: March 22, 2001

PRIORITY-DATA: 2000US-532617 (March 22, 2000)

INT-CL (IPC): G06 F 17/30; G01 C 21/00; G08 G 1/0969; G09 B 29/00

ABSTRACT:

PROBLEM TO BE SOLVED: To provide a method for updating a map data base used in a navigation system and integrating the data of a type different from map data contained in the map data base and a data base architecture constituted so as to perform generalization.

SOLUTION: A data access layer receives a request from a navigation program application to map reference data, accesses the map data base and supplies a response to the request. Logic rules are related to the map data base. The data access layer is provided with a deduction data base engine for accessing and combining the logic rules so as to decide the method for converting the data from a format for which indexes are used so as to access the data from a medium and they are stored in the medium to the format usable by the navigation program application.

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L33: Entry 3 of 9

File: JPAB

Aug 31, 1999

PUB-NO: JP411237250A

DOCUMENT-IDENTIFIER: JP 11237250 A

TITLE: NAVIGATION APPARATUS

PUBN-DATE: August 31, 1999

INVENTOR-INFORMATION:

NAME

COUNTRY

SUZUKI, NORISHIGE

TATEMATSU, MITSUNORI

ASSIGNEE-INFORMATION:

NAME

COUNTRY

CLARION CO LTD

APPL-NO: JP10054298

APPL-DATE: February 19, 1998

INT-CL (IPC): G01 C 21/00; G01 S 1/68; G01 S 5/14; G08 G 1/0969; H04 B 1/16

ABSTRACT:

PROBLEM TO BE SOLVED: To take data of a VICS (road traffic communication system) and a DGPS necessary depending on a reception state by one FM multiplex broadcasting receiver.

SOLUTION: This navigation apparatus has a CPU 4 which detects electric waves from satellites thereby measuring a position of a vehicle, receives DGPS (differential GPS) data updated and transmitted for every predetermined time with FM waves, corrects the measured position of the vehicle in accordance with differential correction data included in the DGPS data, thereby operating highly accurately the position of the vehicle, and controls the whole of a system. In this case, an FM multiplex broadcast-receiving processing part 13 controlled by the CPU 4 switches the DGPS data and VICS data updated and transmitted by a predetermined cycle with FM waves of a different frequency from that of the DGPS data to respective reception frequencies at a predetermined timing, thereby time dividing and receiving the data, and also sends the received VICS and DGPS data to the CPU 4 after carrying out a predetermined process.

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L33: Entry 4 of 9

File: EPAB

Mar 25, 1999

PUB-NO: DE019842430A1

DOCUMENT-IDENTIFIER: DE 19842430 A1

TITLE: Map data processor for vehicle onboard navigation system

PUBN-DATE: March 25, 1999

INVENTOR-INFORMATION:

NAME

COUNTRY

ANDO, KOUICHI

JP

ITO, TORU

JP

ASSIGNEE-INFORMATION:

NAME

COUNTRY

TOYOTA MOTOR CO LTD

JP

APPL-NO: DE19842430

APPL-DATE: September 16, 1998

PRIORITY-DATA: JP25157197A (September 17, 1997)

INT-CL (IPC): G09 B 29/10

EUR-CL (EPC): G09B029/10; G01C021/32

ABSTRACT:

CHG DATE=20000103 STATUS=O>All the card data containing a variety of types are stored in the database (22). An input device (14,16) feeds in differential data received e.g. by a GPS receiver. An updating device (12) updates the data stored in the accumulator and comprises a general processor (28), and a restructuring processor (30). The map data processing device has a map database (22) holding map data which is updated using entered correction data, via an updating device (12) with a processor (28), which stores the correction data separate from the map database and a data reconstruction processor (30), for combining the map data read from the map database with the correction data, to provide new map data entered in the map database.

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L33: Entry 5 of 9

File: TDBD

Dec 1, 1990

TDB-ACC-NO: NN9012177

DISCLOSURE TITLE: Browsing: A Novel Facility for Exploring the Contents of a Datastore.

PUBLICATION-DATA:

IBM Technical Disclosure Bulletin, December 1990, US

VOLUME NUMBER: 33

ISSUE NUMBER: 7

PAGE NUMBER: 177 - 180

PUBLICATION-DATE: December 1, 1990 (19901201)

CROSS REFERENCE: 0018-8689-33-7-177

DISCLOSURE TEXT:

- Disclosed is a facility for a non-expert user to easily explore and update the contents of a datastore in an unplanned manner by navigating from data element to related data element(s). Browsing is designed to be implemented on a windowing system using a visual display terminal. The user browses by operating directly on a graph representing the datastore schema or by selecting action options from data windows. - A datastore is defined as a collection of data elements grouped into classes. Data elements belonging to the same class have the same properties. Individual data elements can be related to other data elements of the same class or other classes by named relationships. - We assume that the properties of data elements take their values from two types of domains: Primitive datatypes, e.g., numbers and character strings whose values can be displayed and updated in a standard manner. - Complex datatypes (long fields), e.g., pictures, drawings, video, etc., whose values need to be displayed and updated using special functions. Properties that have one or more data elements as their values are represented by relationships. - Note that the logical view of the datastore presented to the user may be quite different from the manner in which the data is actually stored. Browser maps the user's requests on the logical model to operations on the physical model. - After the start of a browsing session a current set of data elements is always identified. This can be the set of: (1) data elements belonging to a class, or (2) selected data elements belonging to a class for whom a predicate defined on their properties evaluates TRUE. - And if a current element (defined below) is displayed, the set can further include (3) elements related to the current instance by a given relationship, or (4) selected elements (as defined above) related to the current instance by a given relationship. - A set of type 1 is selected from a graphical display of a database schema where the nodes of the graph represent classes and the arcs represent relationships. A set of type 2 can be specified by selecting a set of type 1 and then bringing up a window, showing the properties of that class, into which selection criteria can be entered. Sets of types 3 and 4 can be specified by selecting a relationship from the graphical display or by bringing up a list of the relationships that the current instance participates in and selecting from them. Selection criteria can be specified as above. - After selecting a current set the user can choose to display the elements in the current set in a data window as follows: One element at a time in a window -- this is the

current element. - As a table in a window with a selectable current element. As the table may be very large, the table window will display only a few elements. - The window can be scrolled to display other elements. - A single element window is, essentially, a list of property names and values. The values of primitive properties are displayed directly as numbers and character strings and can be overtyped for updating. The values of complex properties are not displayed. In the space where the value would appear, Browser displays a button. Selecting the button brings up a menu that can be used to query information about the property, display it in another window, update it, etc. Browser provides a customizable function which can be extended to include facilities for working with new complex datatypes by incorporating routines to display and update these datatypes and special routines, e.g., to rotate drawings. - The single element display window has action buttons for scrolling the properties, if necessary, displaying the next or previous data element in the set, navigating relationships from this element, closing the browsing session, etc. In the table window the top line shows the property names and succeeding lines show property values as described above. The table window has action buttons for scrolling up and down and left and right, navigating relationships from the selected element, closing the browsing session, etc. - The current set may be ordered by the value of a function defined on the properties of the elements or by the default ordering provided by the datastore. It may be examined front-to-back or back-to-front. This determines the order of the rows in a table window or the order in which the data elements are displayed in response to the NEXT command from an individual data element display. - At the start of a browsing session, the user sees a graphical display of the datastore schema. From this an initial current set is selected. After a current data element is displayed, the user can: Change the properties of the current data element by overtyping the displayed values and asking for the values to be updated in the datastore. An undo function is also provided. - If the current element is displayed in a single window, display the next or previous element in the current set and make it the current element. - The new current element is displayed in a window of its own which may or may not overlay previously displayed windows. - If the current set is displayed as a table, the user can select a different displayed element as the current element or scroll the table to expose other data elements in the set. - Select a new current set from the schema diagram and display its first or last elements in an individual window or the first or last few elements in a table window. - Make a previously displayed data element or table window the current element or set. - The browsing facility should be implemented as an application written using a windowing system. To display the data elements requested by the user, the browsing application will need to bring data from the datastore to main storage for display. It should retain in its main storage only the data elements currently displayed on the screen. For example, if a table window is displayed, the facility should bring into main memory only the elements to be displayed in the window at that time. If the window is scrolled, some or all of the elements currently displayed will not be displayed. These should be released from main memory and the new elements that are to be displayed should be brought in. The principle is that the user will keep on the screen what is needed in terms of information or points to navigate from. - The user can explore the contents of the datastore mainly by making selections from displayed options. Little knowledge to start explorations is needed. As the user navigates from data window to data window, the path taken can get very complex. We describe a facility for providing information about the path in beenl|. - For example, a user browsing an Entity-Relationship database would start with a display of the database schema as a graph: the nodes representing entity-types and arcs representing relationships. The current set could include all or selected entities of a type or all or selected entities related to the current entity by a particular relationship. A browsing facility for a semantic data model would be very similar to that for a Entity-Relationship database. For a relational database, the schema graph would display tables as nodes with "meaningful joins" as arcs. The user could display tuples or tables in data windows and navigate to display other tuples and tables using the "meaningful joins". - The Browsing facility described above is independent of the

data model. Thus, it can be used to present a uniform interface to several different data models: hierarchical, entity-relationship, semantic and relational. In the described facility, data is presented in multiple windows that can be independently moved, scrolled and sized. This allows the user to retain multiple related data elements on the display. Further, the user can go to any displayed instance and start a new navigation path. - Also provided is the ability to work with simple and complex properties and to incorporate user-defined functions to work with complex properties. - The above facility describes a large number of features. The design is for what we believe to be a facility that real database users would be able to use. Examples of earlier systems over which the Browser facility provides improvement are described in been2-6|. - References (1) "Displaying Path Information in a Graphical Browsing Facility," IBM Technical Disclosure Bulletin 33, 164-166 (December 1990, this issue). (2) D. Fogg, "Lessons from a "Living In a Database" Graphical Query Interface," Proc . SIGMOD, 100-106 (1984). (3) L. M. Burns, A. Malhotra and D. P. Pazel, "BROWSER: A Visual, Interactive Database Interface," RC 10964, IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y. 10598 (January 1985). (4) K. J. Goldman, S. Goldman, P. Kannellakis and S. B. Zdonick, "ISIS: Interface for a Semantic Information System," Proc . SIGMOD 328-343 (1985). (5) T. R. Rogers and R. G. G. Cattell, "Entity-Relationship Database User Interfaces", Proc . 6th Intl . Conf . on Entity-Relationship Approach, 323-336 (1987). (6) L. M. Burns, A. Malhotra, and J. L. Archibald, "A Graphical Entity-Relationship Database Browser," Proc . HICSS'88 II, 694-704 (1988).

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L33: Entry 7 of 9

File: DWPI

Mar 23, 2001

DERWENT-ACC-NO: 2001-311947

DERWENT-WEEK: 200270

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TITLE: Updating information generating method for map database involves editing old map and Correcting graphics using separate updating information

INVENTOR: KATO, N

PATENT-ASSIGNEE: NIPPONDENSO CO LTD (NPDE), DENSO CORP (NPDE)

PRIORITY-DATA: 1999JP-0245414 (August 31, 1999)

Search Selected

Search ALL

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PATENT-FAMILY:

	PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
<input type="checkbox"/>	<u>JP 2001075967 A</u>	March 23, 2001		013	G06F017/30
<input type="checkbox"/>	<u>US 6453233 B1</u>	September 17, 2002		000	G06F017/30

APPLICATION-DATA:

PUB-NO	APPL-DATE	APPL-NO	DESCRIPTOR
JP2001075967A	August 31, 1999	1999JP-0245414	
US 6453233B1	August 28, 2000	2000US-0649819	

INT-CL (IPC): G06 F 12/00; G06 F 17/30; G06 T 1/00; G08 G 1/0969; G09 B 29/00; G09 B 29/02

ABSTRACTED-PUB-NO: JP2001075967A

BASIC-ABSTRACT:

NOVELTY - The latest and old map data obtained from the memory one compared. Based on the comparison, the differential data is obtained relevant to discriminating information. The old map and differential data one edited, to obtain updating information relevant to map. The graphic data in the map is corrected, based on separate updating information.

DETAILED DESCRIPTION - The new map component data relevant to each graphic data is produced and stored in the memory. The standard discriminative information is added to the old and new map date. Depending on storage position of graphics in the map, the updating information is produced. An INDEPENDENT CLAIM is also included for the map data differential updating system.

USE - For updating map database stored in CD-ROM and DVD-ROM in vehicle mounted navigation apparatus.

ADVANTAGE - Ensures updatation of stored map date relevant to latest condition reliably.

DESCRIPTION OF DRAWING(S) - The figure shows the explanatory view representing relation between map component data and map date. (Drawing includes non-English language text).

ABSTRACTED-PUB-NO: JP2001075967A
EQUIVALENT-ABSTRACTS:

CHOSEN-DRAWING: Dwg.4/7

DERWENT-CLASS: P85 T01
EPI-CODES: T01-J05B3; T01-J10C9;

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L33: Entry 8 of 9

File: DWPI

Sep 24, 1999

DERWENT-ACC-NO: 1999-594303

DERWENT-WEEK: 199951

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TITLE: Map data forwarding method of vehicle mounted navigation apparatus - involves forwarding corresponding data and its version information to navigation apparatus when data stored by primary memory are newer

PATENT-ASSIGNEE: ALPINE KK (ALPN)

PRIORITY-DATA: 1998JP-0059334 (March 11, 1998)

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PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
<input type="checkbox"/> JP 11257975 A	September 24, 1999		014	G01C021/00

APPLICATION-DATA:

PUB-NO	APPL-DATE	APPL-NO	DESCRIPTOR
JP 11257975A	March 11, 1998	1998JP-0059334	

INT-CL (IPC): G01 C 21/00; G08 G 1/0969; G09 B 29/10; H04 B 7/26

ABSTRACTED-PUB-NO: JP 11257975A

BASIC-ABSTRACT:

NOVELTY - An information center receives and compares version information and area information on corresponding variety data among map data stored in a primary memory. The information center forwards corresponding data and its version information to a navigation apparatus only when data stored by a primary memory are newer. DETAILED DESCRIPTION - The information center has primary and secondary memory units which store map data. The map data are divided and classified for every area to different variety data. A navigation apparatus transmits version information on data stored by variety, and area information which shows area of data to be updated in a secondary memory, to the information center.

USE - In vehicle mounted navigation apparatus.

ADVANTAGE - Shortens data transfer time since only required data are forwarded.

DESCRIPTION OF DRAWING(S) - The figure shows model diagram illustrating data forwarding method of navigation apparatus.

ABSTRACTED-PUB-NO: JP 11257975A

EQUIVALENT-ABSTRACTS:

CHOSEN-DRAWING: Dwg.1/20

DERWENT-CLASS: P85..S02 W02

EPI-CODES: S02-B08G; W02-C03C;

[Previous Doc](#)

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L33: Entry 9 of 9

File: DWPI

Sep 16, 2004

DERWENT-ACC-NO: 1999-541893

DERWENT-WEEK: 200460

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TITLE: Map data processor for vehicle onboard navigation system

INVENTOR: ANDO, K; ITO, T

PATENT-ASSIGNEE: TOYOTA JIDOSHA KK (TOYT)

PRIORITY-DATA: 1997JP-0251571 (September 17, 1997)

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PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
<input type="checkbox"/> <u>DE 19842430 B4</u>	September 16, 2004		000	G09B029/10
<input type="checkbox"/> <u>DE 19842430 A1</u>	March 25, 1999		019	G09B029/10
<input type="checkbox"/> <u>JP 11095657 A</u>	April 9, 1999		012	G09B029/00
<input type="checkbox"/> <u>US 6230098 B1</u>	May 8, 2001		000	G01C021/00
<input type="checkbox"/> <u>JP 3500928 B2</u>	February 23, 2004		012	G09B029/00

APPLICATION-DATA:

PUB-NO	APPL-DATE	APPL-NO	DESCRIPTOR
DE 19842430B4	September 16, 1998	1998DE-1042430	
DE 19842430A1	September 16, 1998	1998DE-1042430	
JP 11095657A	September 17, 1997	1997JP-0251571	
US 6230098B1	August 31, 1998	1998US-0144262	
JP 3500928B2	September 17, 1997	1997JP-0251571	
JP 3500928B2		JP 11095657	Previous Publ.

INT-CL (IPC): G01 C 21/00; G08 G 1/0969; G09 B 29/00; G09 B 29/10

ABSTRACTED-PUB-NO: DE 19842430A

BASIC-ABSTRACT:

NOVELTY - All the card data containing a variety of types are stored in the database (22). An input device (14,16) feeds in differential data received e.g. by a GPS receiver. An updating device (12) updates the data stored in the accumulator and comprises a general processor (28), and a restructuring processor (30).

DETAILED DESCRIPTION - The map data processing device has a map database (22)

holding map data which is updated using entered correction data, via an updating device (12) with a processor (28), which stores the correction data separate from the map database and a data reconstruction processor (30), for combining the map data read from the map database with the correction data, to provide new map data entered in the map database.

USE - In intelligent transport system for map data used by an automobile onboard navigation system.

ADVANTAGE - The different types of map data held in the map data memory can be individually updated

DESCRIPTION OF DRAWING(S) - The figure shows a block diagram of a map data processing device

updating device 12

input device 14,16

database 22

processor 28

restructuring processor 30

ABSTRACTED-PUB-NO: US 6230098B

EQUIVALENT-ABSTRACTS:

NOVELTY - All the card data containing a variety of types are stored in the database (22). An input device (14,16) feeds in differential data received e.g. by a GPS receiver. An updating device (12) updates the data stored in the accumulator and comprises a general processor (28), and a restructuring processor (30).

DETAILED DESCRIPTION - The map data processing device has a map database (22) holding map data which is updated using entered correction data, via an updating device (12) with a processor (28), which stores the correction data separate from the map database and a data reconstruction processor (30), for combining the map data read from the map database with the correction data, to provide new map data entered in the map database.

USE - In intelligent transport system for map data used by an automobile onboard navigation system.

ADVANTAGE - The different types of map data held in the map data memory can be individually updated

DESCRIPTION OF DRAWING(S) - The figure shows a block diagram of a map data processing device

updating device 12

input device 14,16

database 22

processor 28

restructuring processor 30

CHOSEN-DRAWING: Dwg.1/9

DERWENT-CLASS: P85 S02 T01 W02 W06 X22

EPI-CODES: S02-B08; S02-B08G; T01-C03C; T01-J06B; T01-J07C; W02-C03D; W06-A03A5;
X22-E06;

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L27: Entry 2 of 3

File: USPT

May 8, 2001

US-PAT-NO: 6230098

DOCUMENT-IDENTIFIER: US 6230098 B1

TITLE: Map data processing apparatus and method, and map data processing system

DATE-ISSUED: May 8, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Ando; Kouichi	Susono			JP
Ito; Toru	Nagoya			JP

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Toyota Jidosha Kabushiki Kaisha	Aichi-ken			JP	03

APPL-NO: 09/ 144262 [\[PALM\]](#)

DATE FILED: August 31, 1998

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
JP	9-251571	September 17, 1997

INT-CL: [07] [G01 C 21/00](#)

US-CL-ISSUED: 701/208; 701/211, 340/990, 340/995

US-CL-CURRENT: [701/208](#); [340/990](#), [340/995.18](#), [701/211](#)

FIELD-OF-SEARCH: 701/208, 701/212, 701/211, 701/210, 340/995, 340/990

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

Search Selected

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	PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL
<input type="checkbox"/>	4951212	August 1990	Kurihara et al.	
<input type="checkbox"/>	5406493	April 1995	Goto et al.	701/208
<input type="checkbox"/>	5469360	November 1995	Ihara et al.	701/208
<input type="checkbox"/>	5729731	March 1998	Yajima et al.	707/3
<input type="checkbox"/>	5731978	March 1998	Tamai et al.	701/201

<input type="checkbox"/> <u>5951620</u>	September 1999	Ahrens et al.	701/200
<input type="checkbox"/> <u>6075467</u>	June 2000	Ninagawa	340/995

FOREIGN PATENT DOCUMENTS

FOREIGN-PAT-NO	PUBN-DATE	COUNTRY	US-CL
41 11 147 A1	October 1992	DE	
195 44 382 A1	May 1997	DE	
07261661	October 1995	JP	

ART-UNIT: 361

PRIMARY-EXAMINER: Cuchlinski, Jr.; William A.

ASSISTANT-EXAMINER: Hernandez; Olga

ATTY-AGENT-FIRM: Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P.

ABSTRACT:

On a vehicle side, map data storage section stores map data, which is to be updated by using the latest map data transmitted from an information center. The map data includes map data of a number of types, such as landmark information, drawing data, route calculation data. For drawing data and route calculation data, the information center sends differential data indicative of difference between the latest data held by the center and the map data held by the vehicle. The differential data of the drawing data is stored separately from extant data in the storage section by generating processing section. The differential data of the route calculation data is combined with extant data by restructure processing section to thereby restructure route calculation data. On the other hand, for landmark data, the center transmits full data, which is data corresponding to the entire latest map data, rather than only the difference. The full data is used to overwrite the extant data. As described above, an appropriate update process is performed according to the type of map data.

14 Claims, 9 Drawing figures

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L27: Entry 2 of 3

File: USPT

May 8, 2001

DOCUMENT-IDENTIFIER: US 6230098 B1

TITLE: Map data processing apparatus and method, and map data processing system

Abstract Text (1):

On a vehicle side, map data storage section stores map data, which is to be updated by using the latest map data transmitted from an information center. The map data includes map data of a number of types, such as landmark information, drawing data, route calculation data. For drawing data and route calculation data, the information center sends differential data indicative of difference between the latest data held by the center and the map data held by the vehicle. The differential data of the drawing data is stored separately from extant data in the storage section by generating processing section. The differential data of the route calculation data is combined with extant data by restructure processing section to thereby restructure route calculation data. On the other hand, for landmark data, the center transmits full data, which is data corresponding to the entire latest map data, rather than only the difference. The full data is used to overwrite the extant data. As described above, an appropriate update process is performed according to the type of map data.

Application Filing Date (1):

19980831

Brief Summary Text (3):

The present invention relates to a map data processing apparatus and method for updating map data stored in a map data storing means using the latest map data. The present invention also relates to a map data processing system including the map data processing apparatus.

Brief Summary Text (5):

Electronic apparatuses using map data are well known. A typical example of such an apparatus is a vehicle-use navigation system. In a conventional navigation apparatus, map data is stored in a storage medium, such as a CD-ROM, and the entire storage medium is generally exchanged for a new one in order to update the map data stored therein when the use of newer map data is required for accurate navigation.

Brief Summary Text (6):

Meanwhile, a vehicle information system proposal has attracted attention as part of what is known as ITS (Intelligent Transport Systems). In this vehicle information system, various useful information is supplied from an information center to a vehicle via data communication. The offer of the latest map data via communication is also proposed with an expectation such that it may facilitate map data updating.

Brief Summary Text (7):

Japanese Patent Laid-open No. Hei 8-305282 discloses an example of a system in which map data is updated using communication. In this system, an information system has the latest map data, and data communication is carried out between the information center and an on-vehicle navigation apparatus. In the navigation apparatus, map data is stored so as to be read/written in a storing means. For updating the map data stored on the vehicle side, whether or not the stored map

data is the latest is determined based on the detected version number. If the data is not the latest version, the latest map data is transmitted from the information center.

Brief Summary Text (8):

The above JP laid-open No. Hei 8-305282 also discloses transmission of differential data from an information center to a vehicle to achieve map data updating in a shorter time. Differential data is data indicative of difference between the latest map data held by the center and older map data held by a vehicle. As differential data has a significantly smaller volume compared to the whole of original map data, it can be transmitted in a shorter time.

Brief Summary Text (9):

In map data updating, it is desirable that processing be completed within the shortest time as possible. Utilizing the above mentioned differential data is one of effective means to increase the update-processing speed. Further, in an updating process, it is important to ensure ease with which updated map data is used in a navigation-related process. That is, it is desirable that an updating process does not result in complicating a process using map data. It is expected that an updating process can be optimized by achieving high-speed update-processing while ensuring ease in using updated map data.

Brief Summary Text (10):

However, at the present stage, map data transmission to a vehicle via communication is still being studied, and none of the conventional technologies takes into consideration compatibility between high-speed update-processing and ease in using updated map data. Therefore, it has been difficult to carry out truly efficient map data updating.

Brief Summary Text (11):

In particular, map data used in a navigation apparatus consists of map data in a number of types. In other words, such total map data is a collection of map data of a number of types. Various map data, such as map data for drawing, for route calculation, and for map matching, may often have different purposes and uses.

Brief Summary Text (12):

In view of high-speed processing and ease in using updated map data, optimum update-processing may differ for every map data. That is, application of similar map data processing may result in significant difference in processing speeds or ease in using map data depending on the type of map data. However, the difference in the nature of respective map data has not conventionally been taken into consideration. As a result, ease in using updated map data may be damaged through application of inappropriate processing.

Brief Summary Text (14):

The present invention has been conceived to overcome the above problems and aims to provide a map data processing apparatus and method for optimizing an update process through employment of a process most suitable for each type of map data.

Brief Summary Text (15):

In order to achieve the above object, according to a first aspect of the present invention, a differential data is used and stored in a storage means in different methods determined so as to accord each type of map data. According to a second aspect, whether or not to use differential data or general data is selected. According to a third aspect, combination of the first and second aspects will result in more favorable updating processing.

Brief Summary Text (16):

(1) According to the first aspect of the present invention, there is provided a map data processing apparatus comprising map data storage section for storing total map

data comprising map data of a number of types, input means for inputting differential data with respect to map data of at least one type, in which differential data indicates difference between the latest map data and corresponding map data stored in the map data storage means, and updating means for updating map data stored in the map data storage means using the differential data.

Brief Summary Text (17):

The updating means has a general processing means and a restructure processing means. The general processing means stores differential data separately from extant map data in the map data storing means. The restructure processing means reads map data from the map data storing means, combines the read data and the differential data to thereby restructure map data, and stores restructured map data in the map data storage means. Restructured map data contains the last data and is still usable in the same method as with the map data before updating.

Brief Summary Text (18):

According to the present invention, either general processing means or restructure processing means is selectable in an updating process using differential data. General processing means would complete updating processing easily in a short time, though it would result in separately stored map data. Therefore, data to be preferably processed through general processing are those which can be easily processed despite separately filed differential data and pre-updating map data. Specifically, drawing data for navigation is preferably processed through general processing.

Brief Summary Text (19):

On the other hand, updating processing through restructure processing is more complicated and takes a longer time than through general processing. However, it ensures ease in using data as updated data can be used similarly before the updating process. Therefore, data to be preferably processed through restructure processing are those which cannot be easily used when differential data and map data before updating are separately filed. Route calculation data for navigation is an example of such data.

Brief Summary Text (20):

As described above, according to the present invention, positive employment of general processing can increase the update-processing speed, while employment of restructure processing if necessary can ensure ease in using updated data. In short, it is possible to achieve a high-speed updating while ensuring ease of map data use.

Brief Summary Text (23):

(2) According to a second aspect of the present invention, there is provided a map data processing system for updating map data held by an on-vehicle terminal device, using latest map data transmitted from an information center to the on-vehicle terminal device. The information center comprises a selection means for selecting, with respect to each map data of a number of types consisting total map data, either differential data transmission or full data transmission, the differential data indicative of difference between latest map data and corresponding map data held by the on-vehicle terminal device, the full data being whole latest data. The on-vehicle terminal device comprises map data storage means for storing map data and updating means for updating the map data stored in said map data storage means, using the differential data or full data transmitted from the information center. The updating means has full data updating means for replacing map data corresponding to the full data, stored in said map storage means with the full data, and differential data updating means for performing update processing using said the differential data.

Brief Summary Text (24):

According to this aspect, whether to transmit differential data or full data is selected according to the type of map data. Differential data is preferable for reduction of a communication time and time to write data into the storage means. However, transmission of differential data may resultantly complicate subsequent processes for storing or utilizing data on the vehicle side. With respect to such data, full data is transmitted. For example, sales outlet information may be transmitted in the form of full data because such data may be updated at a relatively high frequency, and successive transmission of differential data may complicate subsequent data processing on the vehicle side. On the other hand, updating frequency is low with drawing data, and thus differential data may not complicate subsequent processing. Rather, differential data is preferable in that it can reduce transmitting data volume of drawing data which generally has an ample data volume.

Brief Summary Text (25):

As described above, according to the present invention, positive employment of differential data processing can increase the updating processing speed, while employment of full data processing when necessary can ensure ease in using updated data. In short, it is possible to achieve a high-speed updating while ensuring ease in using map data.

Brief Summary Text (26):

(3) Preferably, the differential data updating means according to the second aspect has a general processing means and a restructure processing means according to the first aspect. A general processing means and a restructure processing means are selectable based on the type of map data corresponding to the differential data sent by the information center. With this arrangement, in addition to preferable employment of either full or differential data for data transmission, general and restructure processing is appropriately selected in an update process using differential data, which will contribute to optimizing the update process.

Drawing Description Text (4):

FIG. 2 is a diagram showing map data of a number of types stored in a map data base storage section of a navigation apparatus;

Drawing Description Text (5):

FIG. 3 is a diagram illustrating update processes different from each type of map data;

Drawing Description Text (7):

FIG. 5 is a flowchart of a process for drawing a map using drawing data and differential data thereof;

Drawing Description Text (8):

FIG. 6 is a diagram illustrating a restructure process using route calculation data and differential data thereof;

Drawing Description Text (9):

FIG. 7 is a schematic flowchart of a map data update process performed on a vehicle side;

Drawing Description Text (10):

FIG. 8 is a diagram showing data storage regions in the map data base storage section in the navigation apparatus; and

Detailed Description Text (3):

Referring to FIG. 1, which is a block diagram showing a complete structure of this embodiment, a map data processing apparatus of this invention is integrally formed on a vehicle-use navigation apparatus 10 mounted on a vehicle. The navigation apparatus 10 and an information center 50 together constitute a map data processing

system of this invention.

Detailed Description Text (4):

The navigation apparatus 10 has a navigation ECU 12 which is responsible for comprehensive control over the apparatus 10. The navigation ECU 12 is connected to a GPS (global positioning system) apparatus 14 for detecting a present position based on electric waves transmitted from a man-made satellite to transmit the positional information to the navigation ECU 12. The navigation ECU 12 is further connected to an input device through which a user inputs various information, such as destination information. The navigation ECU 12 is still further connected to an output means, such as a display 18 and a speaker 20. The display 18 shows a map for route guidance, while the speaker 20 outputs audio guidance, if necessity.

Detailed Description Text (5):

The navigation ECU 12 is also connected to a map data base storage section 22 for storing map data for use in various navigation-related processes. The storage section 22 is a data readable/writable memory device. For example, a flash RAM or a hard disk device may constitute a preferable storing means. In this embodiment, the storage section 22 is a hard disk device.

Detailed Description Text (7):

The navigation ECU 12 performs various navigation-related processes using map data stored in the storage section 22. Drawing map data 102 is used to draw a map indicative of the shape of roads or geographic shapes. Image data of a drawn map is outputted to the display 18 for display. Route calculation data 104 is used to search an optimum route from the start point to the destination. A known Dijkstra method may be used for route calculation. MM (map matching) data 106 is used in a map matching process for correcting a present position detected by the GPS apparatus 14. Guidance data 108 has various information (such as a gas station as a mark for a crossing) usable in route guidance. By using the information, route guidance, such as, direction changing, is made. Place name searching data 110 is used to set a destination. A screen image for searching is shown in the display 18 so that the user operates the input device 16 while looking at the displayed image. Landmark information 112 concerns sales outlets, presenting names, addresses, business hours, and business classifications of the sales outlets. The landmark information 112 is automatically outputted via the display 18 or the speaker 20 according to a user's instruction. Name data 114 relates to the names of roads, and is shown as superimposed on a map in the display 18.

Detailed Description Text (8):

Referring again to FIG. 1, the navigation ECU 12 is further connected to a data receiving device 32 for receiving the latest map data transmitted from the information center 50 carried by broadcasting waves via a broadcasting station 40, to forward to the navigation ECU 12.

Detailed Description Text (9):

The information center 50 has a center controlling section 52 which is responsible for comprehensive control over the center 50. The center controlling section 52 is connected to a latest map data base storage section 54. The storage section 54 stores map data in the same format as on the vehicles side (see FIG. 2). The center 50 externally receives the latest information in succession, so that map data in the storage section 54 is updated based on the supplied information. For example, when a new road is built, drawing data and route calculation data are updated. Also, when the name, address, business hour, or business classification of a sales outlet is changed, landmark information is updated. That is, the storage section 54 always stores the latest map data.

Detailed Description Text (10):

The center controlling section 52 retrieves the latest map data from the latest map data base storage section 54, and sends the data to the broadcasting station 40.

Received the data, the station 40 broadcasts the data carried by broadcasting electric waves. The broadcast latest map data is received by the data receiving device 32, and forwarded to the navigation ECU 12. Using the received latest map data, the navigation ECU 12 updates the map data stored in the map data base storage section 22. The navigation ECU 12 has a full data processing section 24 and a differential data processing section 26 for controlling an update process. The differential data processing section 26 has a general processing section 28 and a restructure processing section 30.

Detailed Description Text (11):

Next, a map data updating process in this embodiment will be described in detail.

Detailed Description Text (12):

Map data stored in the map data base storage section 22 of the navigation apparatus 10 is completely updated annually at a predetermined timing. For annual updating, a computer device is directly connected to the navigation apparatus 10 so that the whole content of the hard disk is updated. During a period after the complete map data updating and before the next one, map data is updated using data communication. This preferred embodiment is characterized by the fact that map data is updated in different updating processes determined depending on the type of the data. In the following, updating processes with respect to landmark information 112, drawing data 102, and route calculation data 104 will be separately described with reference to FIG. 3.

Detailed Description Text (13):

Updating of Landmark Information

Detailed Description Text (14):

Landmark information includes information concerning sales outlets or the like. Every time the names, addresses, business hours, and business classifications of sales outlets are changed, the information center 50 obtains new information. As information regarding sales outlets is frequently changed, landmark information may be changed with high frequency. In a case in which landmark information is transmitted in the form of differential data (described later) from the information center to a vehicle, differential data may be frequently transmitted, and sufficient differential data must be processed in order to present landmark information to a user on the vehicle side, which may complicate the process taking place on the vehicle side. Therefore, as to landmark information, the latest map data is transmitted intact, rather in the form of differential data. This latest map data is referred to as "ull data"

Detailed Description Text (16):

Referring to FIG. 3, the data receiving device 32 on the vehicle side receives full data of landmark information. The received data is forwarded to the navigation ECU 12, so that the full data processing section 24 writes the received latest landmark information over the corresponding landmark information stored in the storage section 22 to thereby update the landmark information. With this overwriting, the latest landmark information is stored in the storage section 22 after updating, as shown in the right lower part of FIG. 3. The latest landmark information is thereafter used for navigation.

Detailed Description Text (17):

Name data is also to be updated using full data, similar to the landmark information 112 (see FIG. 3), as is updated with relatively high frequency. Besides, preferably, guidance data 108 may also be similarly processed using full data.

Detailed Description Text (18):

Updating of Drawing Data

Detailed Description Text (20):

In actuality, as roads or bridges are not often newly built, updating frequency may be low with drawing data. Therefore, the use of differential data for updating drawing map data may not cause a problem as is described above with landmark data, that is, too much differential data must be dealt with. Rather, the use of differential data is beneficial in that it can reduce a transmission time which would be long if the whole drawing data having a large volume was transmitted. Therefore, drawing data is transmitted in the form of differential data from the information center 50 to a vehicle. Selection and determination as to whether or not drawing data is sent in the form of differential data is made by the selecting section 56 of the center controlling section 52.

Detailed Description Text (21):

In the example shown in FIG. 4, map data in the storage section 22 on the vehicle side is completely updated every year on April. 1. During the first period after the complete updating, differential data 1 is transmitted from the broadcasting station 40, in which the differential data 1 indicates information acquired during the first period. That is, the differential data 1 indicates difference between the latest drawing data and the drawing data as of the last complete updating.

Detailed Description Text (22):

During the second period following the first period, differential data 2 is prepared in the information center. Differential data 2 indicates newly acquired information during the second period. During the second period, differential data 1 and 2 are both transmitted from the information center. In other words, not only differential data 2 but also differential data 1 are supplied so that a user who bought a navigation apparatus 10 of this embodiment during the second period can also access to the differential data 1 pertaining to the first period. Similarly, during the third period, differential data 1, 2, and 3 are transmitted to the vehicle.

Detailed Description Text (23):

As shown in the drawing, the period from one complete data updating to the next one is divided into three parts. Alternatively, the period may preferably be divided into four or more parts. The larger number of parts the period is divided into, the newer information a vehicle can receive on a real time basis.

Detailed Description Text (24):

As described above, differential data of drawing data is transmitted from the information center 50 to the broadcasting station 40, so that the station 40 broadcasts the received information as carried by broadcasting electric waves. The broadcast differential data is received by the data receiving device 32, and forwarded to the navigation ECU 12. The ECU 12 updates the map data stored in the map data base storage section 22, using the supplied differential data.

Detailed Description Text (25):

In the above operation, general processing is given to the differential data of drawing data, different from route calculation data (described later). That is, the navigation ECU 12 has a differential data processing section 26 for map data updating using differential data. The differential data processing section 26 in turn has a general processing section 28 and a restructure processing section 30. Differential data of drawing data is processed by the former, or the general processing section 28.

Detailed Description Text (26):

Referring again to FIG. 3, the differential data of drawing data which was transmitted from the information center 50 is shown in the upper part of the drawing, while the map data currently stored in the storage section 22, which was written at the previous complete updating, is shown in the lower part thereof. The general processing section 28 writes the received differential data into the

storage section 22 so that the differential data is stored therein separately from the extant drawing data. As a result, files for extant drawing data and for differential data exist separately after updating in the storage section 22, as shown in the lower right part the drawing. As described above, general processing results in drawing data stored in a number of divided groups.

Detailed Description Text (27):

Next, the reason for differential data of drawing data being subjected to general processing in this embodiment will be described. (1) General processing can easily take place in a short time with writing of differential data into the storage section 22 occupying the majority part of the processing. (2) separately stored files of extant drawing data and of differential data will not adversely affect the ease in conducting a drawing process using the data.

Detailed Description Text (28):

The above reason (2) will next be described with reference to FIG. 5, which is a flowchart of a process followed by the navigation ECU 12 to draw a map using drawing data and differential data. In this example, the storage section 22 currently stores drawing data, which is basic data, and differential data 1 and 2. As described referring to FIG. 4, differential data 2 was acquired after differential data 1, and contains new information which is not included in the differential data 1.

Detailed Description Text (29):

In a drawing process, the navigation ECU 12 initially accesses the basic drawing data file so as to carry out a drawing process using the data (S10). Then, the navigation ECU 12 accesses the differential data 1 file so that the shape of roads described in the data 1 is displayed as superimposed on the map drawn at S10 (S12). Subsequently, the navigation ECU 12 accesses the differential data 2 file so that the shape of roads described in the differential data 2 is displayed as superimposed on the map drawn at S10 and S12 (S14). After the drawing process is completed as described above, image data of the drawn map is sent to the display 18 to be displayed. When following the above procedure, a drawing process can be easily carried out, avoiding complexity, even using separately filed drawing and differential data.

Detailed Description Text (30):

As described above, when drawing data is updated through general processing, map data can be updated simply and easily while ensuring ease in performing a subsequent drawing process using the updated data. For the same reason described above, preferably, MM (map matching) data may be similarly processed, i.e., through general processing using differential data.

Detailed Description Text (31):

Updating of Route Calculation Data

Detailed Description Text (32):

Differential data is used when updating route calculation data. Updating frequency with route calculation data may be low, similar to drawing data. Therefore, the use of differential data for updating may reduce the transmitting data volume between the information center and a vehicle. Data transmission is made using the same method as is used with drawing data. Selection and determination as to whether or not route calculation data is sent in the form of differential data, is made by the selecting section 56 of the center controlling section 52.

Detailed Description Text (33):

On the vehicle side, the data receiving device 32 receives the transmitted differential data of route calculation data, and forwards the data to the navigation ECU 12. Using the supplied differential data, the ECU 12 updates the map data stored in the map data base storage section 22. Here, for updating,

restructure processing is employed to the differential data of route calculation data by the restructure processing section 30 of the navigation ECU 12.

Detailed Description Text (34):

Referring again to FIG. 3, the differential data of route calculation data which was transmitted from the information center 50 is shown in the upper part of FIG. 3, while the route calculation data currently stored in the storage section 22, which was written at the previous complete updating, is shown in the lower part thereof. The restructure processing section 30 reads the extant route calculation data from the storage section 22 to combine with the newly supplied differential data to thereby restructure the route calculation data. The restructured route calculation data can thereafter be used for route guidance using the same method as is used with the route calculation data before restructure. The restructured data has information regarding, for example, the latest shapes of roads. In other words, the data is equivalent, in terms of available information, to the latest data held in the information center 50. Restructured data is written into the storage section 22, which is shown in the lower right part of the drawing.

Detailed Description Text (36):

Referring to the upper part of the drawing, showing route calculation data before updating, take node 5 for an example. The links connecting nodes 5 and 3, and nodes 5 and 6 represent two-way roads. Therefore, node 5 is connected to both nodes 3 and 6 (it is possible to reach both nodes 3 and 6 from node 5).

Detailed Description Text (37):

In an example in which a one-way road is newly build from node 5 to node 4, referring to the lower part of FIG. 6 showing restructured route calculation data, a vehicle acquires differential data indicative of the newly built one-way road. Next, link data before updating is read to be given the data indicative of the newly build road, as represented by a dot line in the drawing. Moreover, as shown by the one-dot chain line m in the lower right part of FIG. 6, nodes 4 and 5 are newly connected to each other. Restructured data is written into the storage section 22.

Detailed Description Text (38):

In the following, the reason why differential data of route calculation data is subjected to restructure processing in this embodiment will be described. Providing that general processing is applied to route calculation data, the data could be updated more easily at a higher speed. However, route calculation data would resultantly be stored as divided in a number of groups. For example, referring to FIG. 6, differential data indicative of the newly build one-way road (link 5.fwdarw.4) and other link data would be stored in different files. This would complicate a subsequent route searching process, and resultantly reduce the calculation speed. Under the current circumstance where an increase of a route calculation speed is desired, this is not preferable. Thus, restructure processing is applied instead to route calculation data, as described above. With this arrangement, it is possible to calculate routes using the same manner before and after the updating. In other words, consistent ease in using route calculation data for route calculation can be maintained before and after updating.

Detailed Description Text (40):

Referring to FIG. 7, showing the flowchart of a complete map data updating process taken place on the vehicle side, it is known from the drawing that different update processes are performed depending on the type of map data, such as landmark information, drawing data, and route calculation data.

Detailed Description Text (41):

In the drawing, the navigation device 10 receives updating data (landmark information, drawing data, route calculation data) sent by the information center (S20). The navigation ECU 12 determines whether or not the received data is

landmark information (S22). Because of the high updating frequency, as described earlier, landmark information must have been sent in the form of full data. In order to update landmark information, the older landmark information is overwritten by the newer information.

Detailed Description Text (42):

If the received data is not landmark information, i.e., "NO" at S22, whether or not received data is drawing data is judged at S26. Because of the low updating frequency and an advantage of significant reduction of a transmission time, as described earlier, drawing data must have been sent in the form of differential data. With respect to the differential data of drawing data, the general processing section 28 carries out general processing (S28). With this arrangement, an updating process can be performed simply in a short time. Even if the drawing data is caused to be stored separately in a number of groups as a result of general processing, that will not adversely affect the ease with which a drawing process is carried out, as described above.

Detailed Description Text (43):

Also, if the received data is not drawing data, i.e., "No" at S26, the received data must be route calculation data. Route calculation data is sent in the form of differential data, similar to drawing data. With respect to the differential data of route calculation data, the restructure processing section 30 carries out restructure processing (S30). In restructure processing, the differential data is combined with the extant route calculation data so that a route calculation process is prevented from being complicated.

Detailed Description Text (44):

Next, referring to FIG. 8, showing a data storage region in the map data base storage section 22 of the navigation apparatus 10, drawing data, route calculation data, landmark information, place name data are stored in the form of a file in respectively assigned regions. The storage section 22 also has a differential data region for storing differential data sent from the information center. Management data, as shown in FIG. 9, manages start address information of respective regions storing the above data files.

Detailed Description Text (45):

When the vehicle receives updating data for landmark information, the received data is written over the extant landmark information. This is also the case with place name data.

Detailed Description Text (46):

Drawing data is sent in the form of differential data. The differential data is written into a differential data region, shown in the lower part of FIG. 8. That is, the differential data region, which has already been loaded with previously acquired differential data 1, additionally stores newly acquired differential data 2. The differential data is stored as separated from the drawing data shown in the upper part of FIG. 8 as a result of general processing applied to the drawing data.

Detailed Description Text (47):

Similarly, route calculation data is sent in the form of differential data, which is temporality written into the differential data region. Then, the differential data and the extant route calculation data are read and combined to thereby prepare restructured route calculation data. The restructured route calculation data is written over the route calculation data before updating. The differential data having been used for restructuring is then deleted from the differential data region.

Detailed Description Text (48):

Note that the data region for route calculation data contains a margin region in

expectation of an increase of a data volume due to restructure. Data regions for landmark information and name place data also contain a margin region to get ready for increased data. On the other hand, a data region for drawing data does not contain a margin region because updating data is written only into the differential data region without affecting the extant drawing data.

Detailed Description Text (49):

As described above, in this embodiment the information center selects a preferable data format, i.e., either full or differential data, for every transmitting data to a vehicle. Differential data is positively used for reduction of a data transmission time, while full data is used with respect to data or information which is not preferably transmitted in the form of differential data, such as landmark information. Moreover, either general or restructure processing is applied to an update process using differential data. General processing is positively used for simplification of update-processing. Restructure processing is used, if necessary, with respect to route calculation data, or the like, so as to ensure the ease with which updated data is used. According to this embodiment, an update process can be carried out easily at a higher speed while ensuring ease in using map data for navigation, or the like.

Detailed Description Text (50):

In a modification of the above embodiment, while the information center 50 sends updating data via a broadcasting station 40 to the navigation apparatus 10 in the above, the information center may carry out data communication with each of the respective vehicles. For individual communication, a radio or cabled communication apparatus (including a telephone) may be used. For example, the navigation apparatus 10 sends, either automatically or upon the user's instruction, a request for updating data to the information center 50. The request includes version information of the map data held by the requesting vehicle. The version may be denoted by an updating date. The version may be different from every type of map data. Based on the version information, the information center 50 sends to the requesting vehicle necessary updating data in the form of either full or differential data. For sending full data, the whole of the latest data is supplied to the requesting vehicle when the vehicle is detected as not having the latest data. For sending differential data, data indicative of the difference between data with the informed version by the vehicle and the latest data, is supplied. Note that a satellite may be used for broadcasting and individual communication.

Current US Original Classification (1):

701/208

Current US Cross Reference Classification (3):

701/211

CLAIMS:

1. A map data update apparatus, comprising:

map data storage means for storing map data including a plurality of information types;

input means for inputting differential data with respect to map data of at least one type, the differential data comprising a difference between latest map data and corresponding map data stored in said map data storage means; and

updating means for updating the map data stored in said map data storage means using the differential data,

said updating means including

processing means for storing the differential data separately from extant map data in said map data storing means; and

restructuring means for combining extant map data read from said map data storage means with the differential data, restructuring the map data, and storing restructured map data in said map data storage means.

2. A map data update apparatus according to claim 1, wherein said input means includes a data receiving device so as to input data externally supplied via data communication.

3. A map data update apparatus, comprising:

map data storage means for storing total map data including map data of a number of types;

input means for inputting differential data with respect to map data of at least one type, the differential data comprising a difference between latest map data and corresponding map data stored in said map data storage means; and

updating means for updating the map data stored in said map data storage means using the differential data,

said updating means including:

processing means for storing the differential data separately from extant map data in said map data storing means; and

restructuring means for combining extant map data read from said map data storage means with the differential data, restructuring the map data, and storing restructured map data in said map data storage means;

wherein said updating means selects either said processing means or said restructuring means for updating according to a type of map data corresponding to the differential data.

4. A map data update apparatus according to claim 3, wherein said processing means updates drawing data for use in route guidance, and said restructuring means updates route calculation data for use in route guidance.

5. A map data update apparatus according to claim 4, wherein said processing means updates also map matching data of a GPS device for use in positional correction, and said restructuring means updates also place name searching data for use in setting a destination for route guidance.

6. A map data update apparatus, comprising:

map data storage means for storing total map data including map data of a number of types having different purposes and embodiments for use;

input means for inputting differential data with respect to map data of at least one type, the differential data comprising a difference between latest map data and corresponding map data stored in said map data storage means; and

updating means for updating the map data stored in said map data storage means using the differential data,

wherein said map data storage means stores map data of at least two types including drawing map data and route calculation data both for use in route guidance,

said updating means includes processing means for storing, when supplied with differential data of drawing data, the differential data separately from extant map data in said map data storing means when said updating means is supplied with differential data comprising drawing data; and

restructuring means for combining, when supplied with differential data of route calculation data, extant route calculation map data read from said map data storage means with the differential data, restructuring route calculation map data, and storing restructured route calculation map data in said map data storage means when said restructuring means is supplied with differential data comprising route calculation data.

7. A map data update method for updating map data stored in map data storage means using latest map data, comprising:

an input step of inputting differential data indicative of a difference between latest map data and corresponding map data stored in said map data storage means;

a processing step of storing the differential data separately from extant map data in said map data storage means;

a restructuring step of reading extant map data from said map data storage means, combining the extant map data with the differential data to restructure the map data, and storing restructured map data in said map data storage means;

wherein either the processing step or the restructuring step is selected according to a type of map data subjected to updating.

8. A map data update method according to claim 7, wherein the map data includes drawing map data and route calculation map data both for use in route guidance, the drawing data being processed in the processing step, the route calculation map being processed in the restructuring step.

9. A map data update system for updating map data held by an on-vehicle terminal device, using the latest map data transmitted from an information center to said on-vehicle terminal device, comprising:

selection means mounted on said information center, for selecting transmission of either differential data or full data with respect to each of map data of a number of types which constitute total map data, the differential data comprising a difference between latest map data and corresponding map data held by said onvehicle terminal device, the full data comprising the entire latest data;

map data storage means mounted on said on-vehicle terminal device for storing map data; and

updating means mounted on said on-vehicle terminal device, for updating the map data stored in said map data storage means, using the differential data or full data transmitted from the information center,

said updating means having full data updating means for replacing map data stored in said map data storage means corresponding to the full data with the full data and differential data updating means for performing update processing using the differential data.

10. A map data update system according to claim 9, wherein said selection means selects transmission of either differential data or full data according to a type of map data.

11. A map data update system according to claim 10, wherein said differential data

updating means has processing means for storing the differential data separately from extant map data in said map data storing means, and restructuring means for combining extant map data read from said map data storage means and the differential data to thereby restructure map data so that restructured map data is stored in said map data storage means, and selects either the processing means or the restructuring means according to a type of map data corresponding to the differential data transmitted from the information center.

12. A map data update system according to claim 11, wherein said selection means selects differential data with respect to drawing data and route calculation data for use in route guidance, and full data with respect to landmark information, which is map data including sales outlet information for use in route guidance.

13. A map data update system according to claim 12, wherein said full data updating means updates the landmark information, said processing means updates the drawing data, and said restructuring means updates the route calculation data.

14. A map data update apparatus for updating map data held using latest map data transmitted from an information center comprising:

map data storage means for storing total map data including map data of a number of types having different purpose and embodiments for use;

receiving means for receiving either differential data or full data from said information center according to types of map data, the differential data indicating difference between latest map data and map data stored on a vehicle side, the full data being equivalent to the latest map data; and

updating means for updating the map data stored in said map data storage means using either the differential data or the full data.

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L27: Entry 1 of 3

File: USPT

Sep 24, 2002

US-PAT-NO: 6456938

DOCUMENT-IDENTIFIER: US 6456938 B1

TITLE: Personal dGPS golf course cartographer, navigator and internet web site with map exchange and tutor

Full	Title	Citation	Front	Review	Classification	Date	Reference	Abstract	Claims	KWIC	Draw D
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☐ 2. Document ID: US 6230098 B1

L27: Entry 2 of 3

File: USPT

May 8, 2001

US-PAT-NO: 6230098

DOCUMENT-IDENTIFIER: US 6230098 B1

TITLE: Map data processing apparatus and method, and map data processing system

Full	Title	Citation	Front	Review	Classification	Date	Reference	Abstract	Claims	KWIC	Draw D
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☐ 3. Document ID: US 6201497 B1

L27: Entry 3 of 3

File: USPT

Mar 13, 2001

US-PAT-NO: 6201497

DOCUMENT-IDENTIFIER: US 6201497 B1

TITLE: Enhanced global navigation satellite system

Full	Title	Citation	Front	Review	Classification	Date	Reference	Abstract	Claims	KWIC	Draw D
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L27: Entry 3 of 3

File: USPT

Mar 13, 2001

US-PAT-NO: 6201497

DOCUMENT-IDENTIFIER: US 6201497 B1

TITLE: Enhanced global navigation satellite system

DATE-ISSUED: March 13, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Snyder; David M.	Cedar Rapids	IA		
Baych; Leslie D.	Cedar Rapids	IA		
Melick; Bruce D.	Cedar Rapids	IA		

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
DLB Limited	Cedar Rapids	IA			02

APPL-NO: 09/ 156448 [\[PALM\]](#)

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PARENT-CASE:

CROSS REFERENCE TO CO-PENDING PROVISIONAL APPLICATION This application claims the benefit under 35 U.S.C. .sctn.119(e) and 37 C.F.R. .sctn.1.78 of copending provisional patent application entitled "Enhanced Global Position System", Ser. No. 60/060,515 filed Sep. 30, 1997, from which this application claims priority. The disclosure of provisional patent application Ser. No. 60/060,515 is hereby incorporated in its entirety.

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US-CL-ISSUED: 342/357.06; 342/357.08, 701/215

US-CL-CURRENT: 342/357.06; 342/357.08, 701/215

FIELD-OF-SEARCH: 342/357.06, 342/357.08, 701/215, 701/213

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

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ART-UNIT: 362

PRIMARY-EXAMINER: Tarcza; Thomas H.

ASSISTANT-EXAMINER: Mull; Fred H.

ATTY-AGENT-FIRM: Harms; Allan L.

ABSTRACT:

An enhanced positioning and navigational system for use within a building or otherwise separated by a line-of-sight barrier from an orbiting global navigation satellite system such as Navstar GPS. An antenna placed at a known location within line of sight of orbiting global navigation satellites receives global position and navigation signals and relays the signals through the line-of-light barrier to an identifier which identifies the signals and couples the signals for individual broadcast from each of an array of broadcast antennae located at known fixed locations within the building (behind the line-of-sight barrier). A receiver located within the building receives the signals broadcast from the antenna array and through use of a processor interprets the signals to provide position and navigation information to the user of the receiver.

In an alternate embodiment, a signal generator generates navigation and positions information signals of a multiplicity of broadcast beacons. The information signals are separated into parcels corresponding to individual beacons and then are separately broadcast from each of all array of antennae located at fixed, known locations within a building. A radio position and navigation receiver equipped with a processor provided with appropriate software receives the signals and provides radio position and navigation receiver information to the user of the GPS receiver. In another alternative embodiment, plural pseudolites are placed at accurately established fixed locations within a building. A controller causes the pseudolites to sequentially broadcast global navigational satellite system signals. A GPS receiver equipped with a processor provided with appropriate software receives the signals and provides navigation and positioning information to the user of the GPS receiver. Alternative methods for sequencing the signals broadcast by the pseudolites are also disclosed.

10 Claims, 4 Drawing figures

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